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AUTHOR Hill, Johnny
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ABSTRACT

This document explores teaching and learning of mathematics apart from what mathematics content is being taught. Cooperative learning and peer tutoring are seen as effective alternatives for providing mathematics instruction in secondary schools. The physical and intellectual environments of the classroom are discussed, with special attention paid to learning styles. It is concluded that several variables affect student achievement and attitude. Further, a variation in teaching strategy to include cooperative learning and peer tutoring might be beneficial. Teachers must be aware of how their styles, classroom conditions, student-student interactions, and student-teacher interactions may influence the attainment of educational objectives. (PK)

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MATHEMATICS LEARNING IN THE SECONDARY SCHOOL

Much of the professional research and development energy of mathematics educators is often devoted to analyzing the curriculum. Should we be teaching long division, should our students be learning more about the structure of mathematics, would the teaching of base six help students learn base ten more effectively, should we teach the metric system, should we do more with graphing functions, should we merge solid geometry with plane geometry, should we emphasize problem solving? These are a few of the questions dealing with, "What is the content of the best mathematics program?" which have commanded the attention of mathematics educators at various times during the past thirty years.

There are, however, other sets of significant questions which have attracted many researchers and sparked debate among teachers in the field. One set of questions might be entitled, "How do we teach mathematics most effectively or how do students learn mathematics most effectively, no matter WHAT mathematics we determine belongs in the school curriculum?"

One probably assumes that there are as many answers to this question as there are teachers. However, it just may be that mathematics is taught much more uniformly than the multiplicity of its practitioners would suggest, perhaps more uniformly than is desirable.

For example, many teachers feel mathematics is an individual subject, that students ought to study mathematics one-on-one. The legendary mathematician R. L. Moore was adamant that graduate students should wrestle with challenging problems alone. Legend even has it that he did not wish students to attend class if an assigned problem they had not worked was to be discussed! Many teachers apparently have at least similar feelings, that somehow, there is a morality, a character-building experience in slugging it out for oneself. This may be true, but research seems to send an additional message, that there is value in cooperative study as well.

Cooperative Study

Several recent studies have examined cooperative learning and peer tutoring. Sherman and Thomas (1986) compared a cooperatively goal-structured classroom with the traditional individualistic classroom and found significantly higher achievement scores for the cooperative group on a unit in percentage taught to ninth and tenth graders. Another study of a similar nature with seventh graders found not only consistently higher achievement scores but also a more positive attitude toward the study of mathematics (Gordon, 1986).

The value of peer tutoring, while certainly not a new topic, has similarly concerned both teachers and researchers. One study conducted in an inner city school established tenth- and twelfth-grade tutors for a group of third graders (Butler, 1986). Tutorial sessions took place after school in 45-minute periods for two sessions per week for an eight-week period. The researcher was looking for achievement and attitude differences as well as certain self-perceptions. Among this study's findings was a significant difference on mathematics subtest raw scores on a standard achievement battery, favoring the scores of the children being tutored over those of the non-tutored. Interestingly, there was no difference in mathematical computational achievement for the third graders tutored by highly mathematically skilled tutors compared to the scores of third graders tutored by those less skilled in mathematics. Among the author's conclusions was that this cross-age tutoring can have a positive effect among low-achieving inner-city youth. These students began to shift toward an internal local of control orientation, that is, to believe they were more in control of what happens to them instead of believing external forces controlled their lives.

Intellectual and Physical Environments

Other studies have examined a plethora of instructional variables influencing student achievement and attitude. Hodges (1986) conducted a study of the relationships between student preferences of classroom physical design and their attitude and achievement. While some comparisons yielded no significant findings, several interrelationships did show significance. Students, for example, achieved higher mean test scores and demonstrated more positive attitudes towards mathematics when placed in instructional settings complementary to their design preferences. One is led to question whether traditional physical settings, including seating restrictions, may in some circumstances actually impede optimal student achievement and the development of positive attitudes toward mathematics.

From a slightly different perspective, Calvano (1986) investigated the influence of student learning styles on the mathematical achievement of high- and low-achieving middle grade students. Her findings confirm other studies which conclude that significant differences exist between the learning styles of these two groups. Students differ by gender and grade level on a variety of variables. Some seem predictable. High achievers prefer to have responsibility for their own work and persistence. Low achievers need experiences with physical materials and teacher motivation. But light, temperature, noise, and the opportunity for mobility also were variables over which grade level and gender groups differed. Calvano believes the set of crucial variables changes as children grow older.

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The gender variables in Calvano's work remind us of the responsibility all classroom teachers share to be aware of our history of perpetuating stereotypes among males and females in the discipline of mathematics. In a study involving students in algebra, Koehler (1986) sought to describe effective instruction and to determine if males and females received different treatment in class. As in the previous study, Koehler also found that the environment most likely to produce gains in high-level algebra classes was one in which the teacher encouraged the development of self-directing learning behaviors among students. On the other hand, students in low-level algebra classes did better if the teacher was active in directive teaching, spent less time in seatwork, and asked more questions of students during the development of the lesson. As has been the case in so many studies, the investigator found males received more of all types of interactions. In this study this difference did not appear to influence achievement. Females seemed to thrive in the more autonomous setting.

Looking at differences between the styles of low and high achievers should remind most teachers of the particularly difficult task of meeting the needs of the talented and gifted students in their classes. These students not only produce better results faster than other pupils but also process information in a different fashion (Span and Overtoom-Corsmit, 1986). In her study Ellerton (1986) found giving students the opportunity to make up their own problems was especially useful for mathematically talented students.

Summary

Thus, from many different perspectives, it is apparent that several variables affect student achievement and attitude. Possibly, a variation in teaching strategy to include peer tutoring or cooperative learning may help solve an instructional problem or give that extra edge in student achievement that outstanding teachers always seek. Teachers also need to be aware of how their style, classroom conditions, student-student interactions, and student-teacher interactions may influence the attaining of educational objectives.

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Prepared by
Johnny Hill, Miami University, Oxford, Ohio

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